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Non-Terrestrial Networks Journey to 5G

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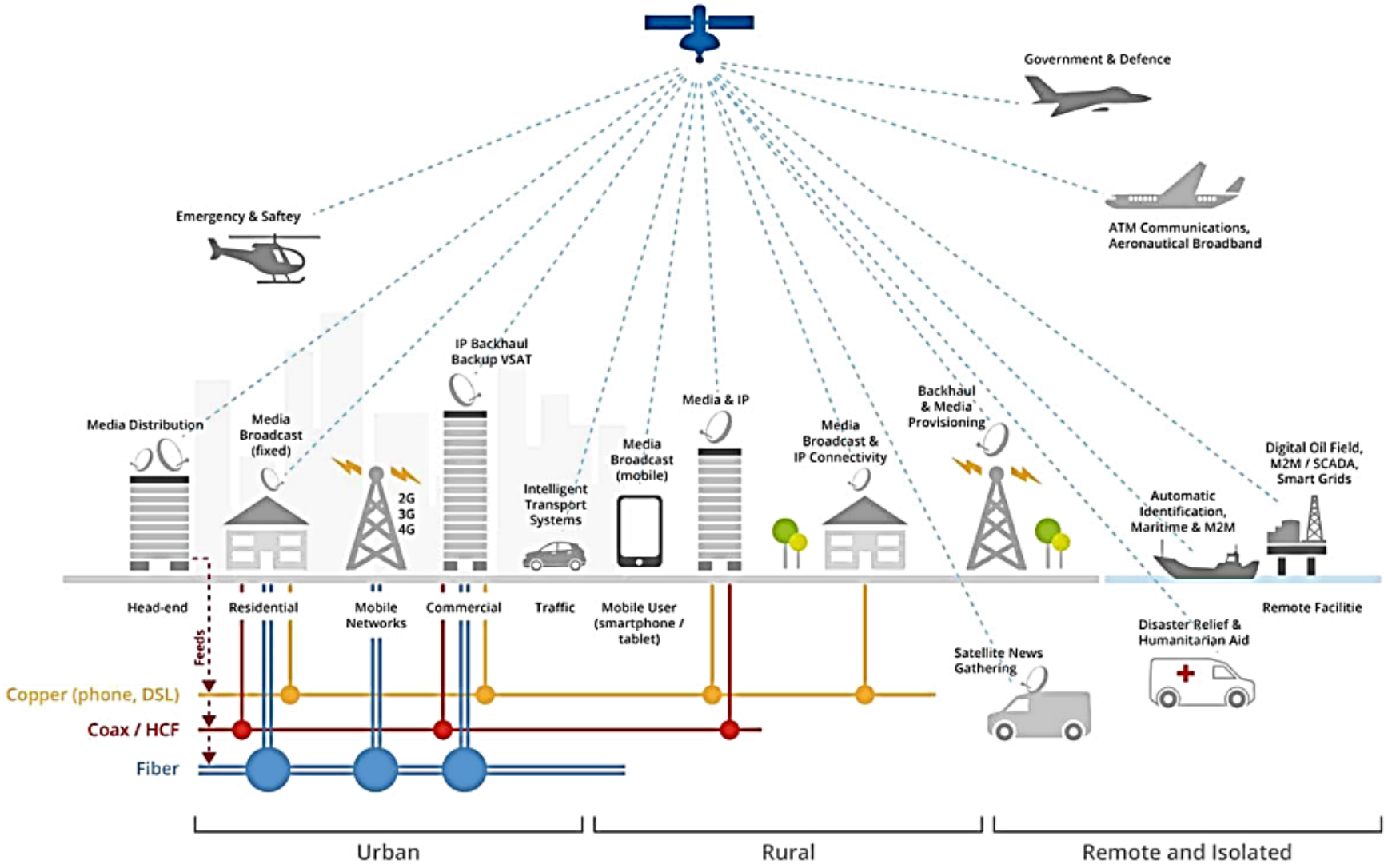
NON-TERRESTRIAL NETWORKS



GEO
35,786 km
~550msec

MEO
2,000-10,000 km
~120msec

LEO
500-2,000 km
~15msec

HAPS
18-22 km
~5msec

SATELLITE NETWORKS ARE CHANGING

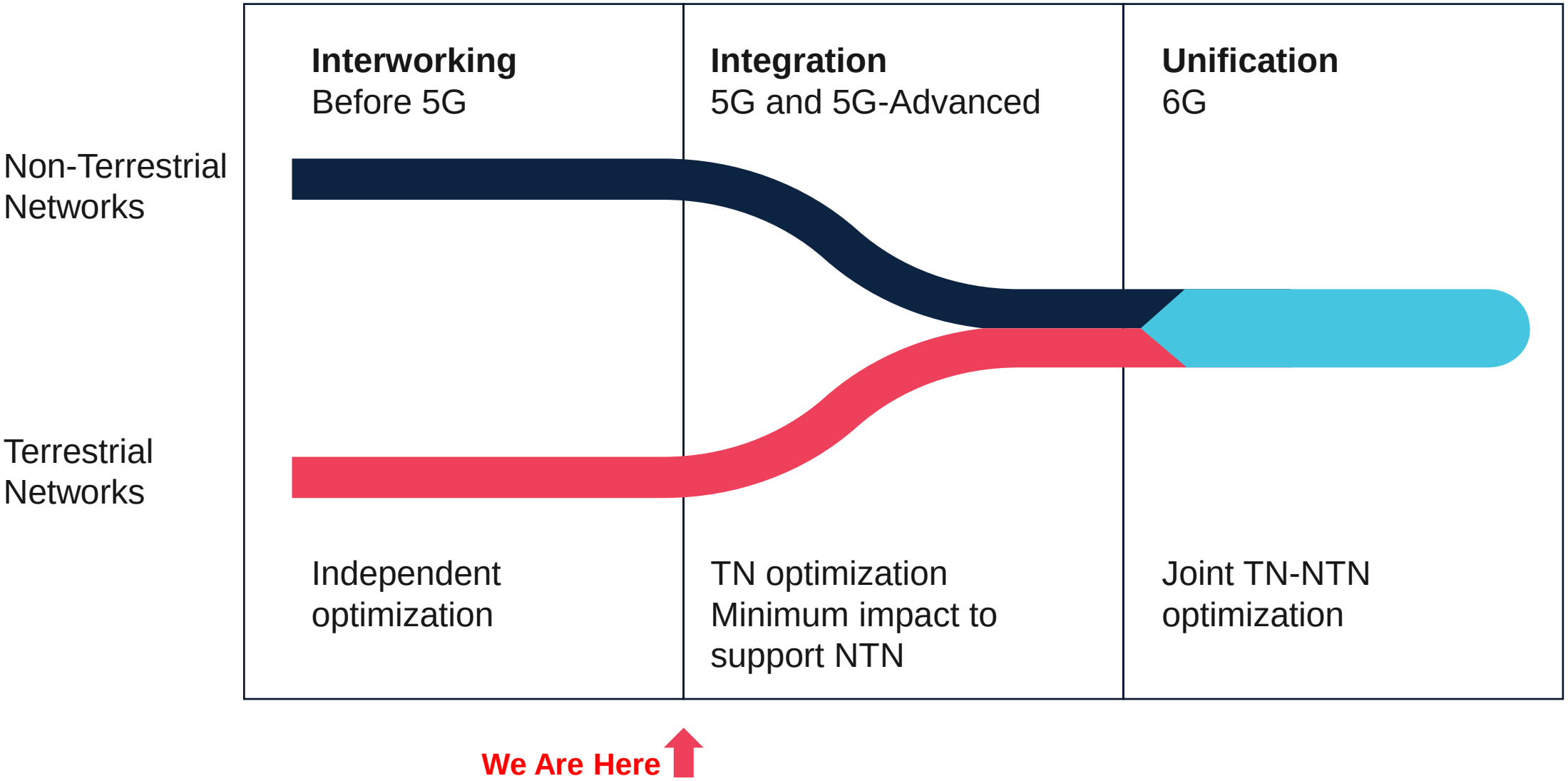
From	To
Physical networks	Virtual & Cloud networks
Fixed Satellite Service (FSS)	High Throughput Satellite (HTS)
Static Satellite capabilities	Flexible Software Defined Satellites (SDS)
Single-Orbit constellations	Multi-Orbit constellations
Transparent Satellites	Regenerative Satellites
Single-vendor closed solutions	Multi-vendor open standard solution
Proprietary Terminals	Standard Terminals
Dedicated Partnerships	Larger Eco-System
Separated TN and NTN networks	Integrated TN and NTN networks

3GPP 5G NTN Standardization will foster those changes

WHAT 5G BRINGS TO THE TABLE

- 5G NR O-RAN
- Mobility Management
- Session Management
- User Management
- Policy Control
- Converged Charging
- Security
- Network Slicing
- Network Data Analytics
- Value Added Services
- Cloud & Edge Compute
- Open Ecosystem

THE PATH TOWARDS UNIFICATION



3GPP NTN STANDARDIZATION

Rel-17

- NR-NTN (5G), IoT-NTN (4G)
- Transparent Satellite architecture
- New NTN bands in FR1 (L, S)
- Time & Frequency Synchronization
- Enhancement for HARQ & RACH
- Mobility Support
- Satellite Ephemeris information

Rel-18

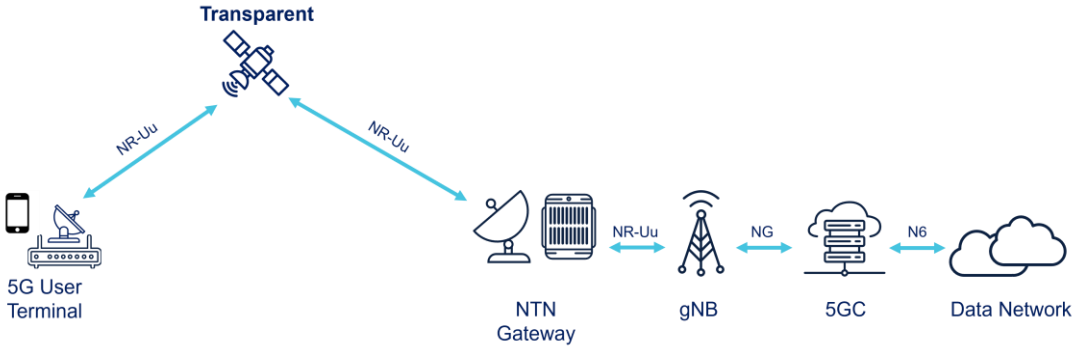
- Transparent Satellite architecture
- New NTN bands in FR2 (Ka)
- NR-NTN further enhancements (mobility, performance, location)
- TN-NTN Mobility & Service Continuity

Rel-19 (tbd)

- Regenerative Satellite architecture
- Coverage Enhancements
- Enhanced GNSS operation
- Multi-orbit connectivity
- Ku band
- NTN-TN Spectrum Coexistence

TRANSPARENT VS. REGENERATIVE ARCHITECTURE

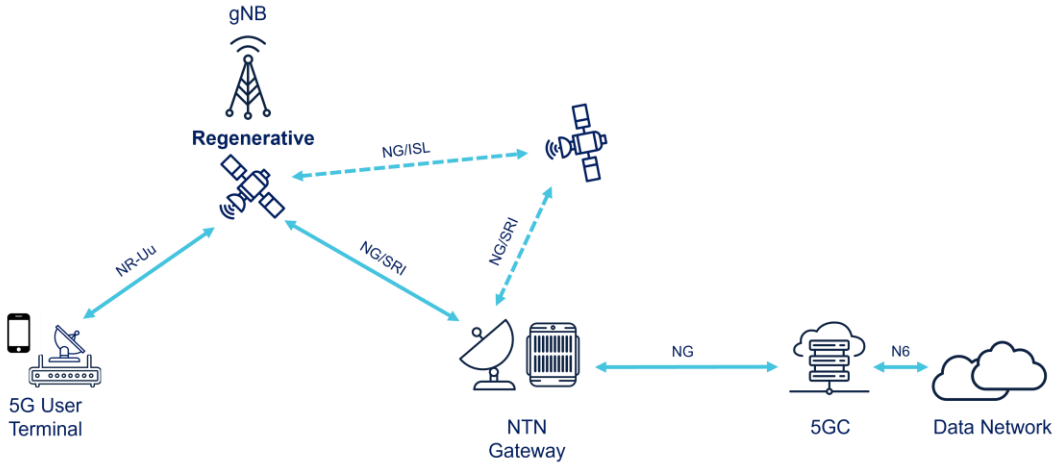
Transparent Payload



- Existing Satellites transparently repeats NR-Uu signal
- NTN Gateway transparently repeats NR-Uu signal
- gNB in ground-segment
- 5GC and Edge Computing in ground-segment/Cloud

- ✓ Simpler solution architecture
- ✓ Lower cost and power
- ○ Limited latency and bandwidth
- ○ No functional flexibility (regular ‘bent-pipe’)

Regenerative Payload



- New Satellites with full-gNB OBP terminates NR-Uu (*+UPF)
- Split option: gNB-DU OBP and gNB-CU on ground-segment
- Inter Satellite Links (ISL) are used for backhaul
- 5GC and Edge Computing in ground-segment/Cloud

- ○ Complex solution architecture
- ○ Higher cost and power
- ✓ Lower latency, higher bandwidth
- ✓ Higher functional flexibility (UT-to-UT, Edge Compute, ISL Backhaul)

SATELLITE SERVICE PROVIDERS – MARKET OUTLOOK

Broadband Service Providers

Operator	Satellite system (deployed)	Spectrum	Technology	Operational	Services
Space X (Starlink)	12000+ (3580)	Ku-band	Proprietary	Yes	Broadband
OneWeb	648 (542)	Ku-band	Proprietary	TBD	Broadband
Kuiper	3236 (0)	Ka band	Proprietary	Estimated 2024	Broadband
Galaxy Space	1000 (7)	Q/V spetrum	Proprietary	TBD	Broadband
Boeing	147 NGSO (1)	V band	Proprietary	TBD	TBD
Inmarsat	14 GEO (14)	TBD	Proprietary	TBD	Broadband to IoT
Telesat	188 (2)	C, Ku, Ka bands	Proprietary	TBD	Broadband
Echostar	10 GEO (10)	Ku, Ka, S bands	Proprietary	Yes	Broadband
HughesNet	3 GEO (2)	Ka band	Proprietary	Yes	Broadband
Viasat	4 GEO (4)	Ka band	Proprietary	Yes	Broadband

IoT and D2D Service Providers

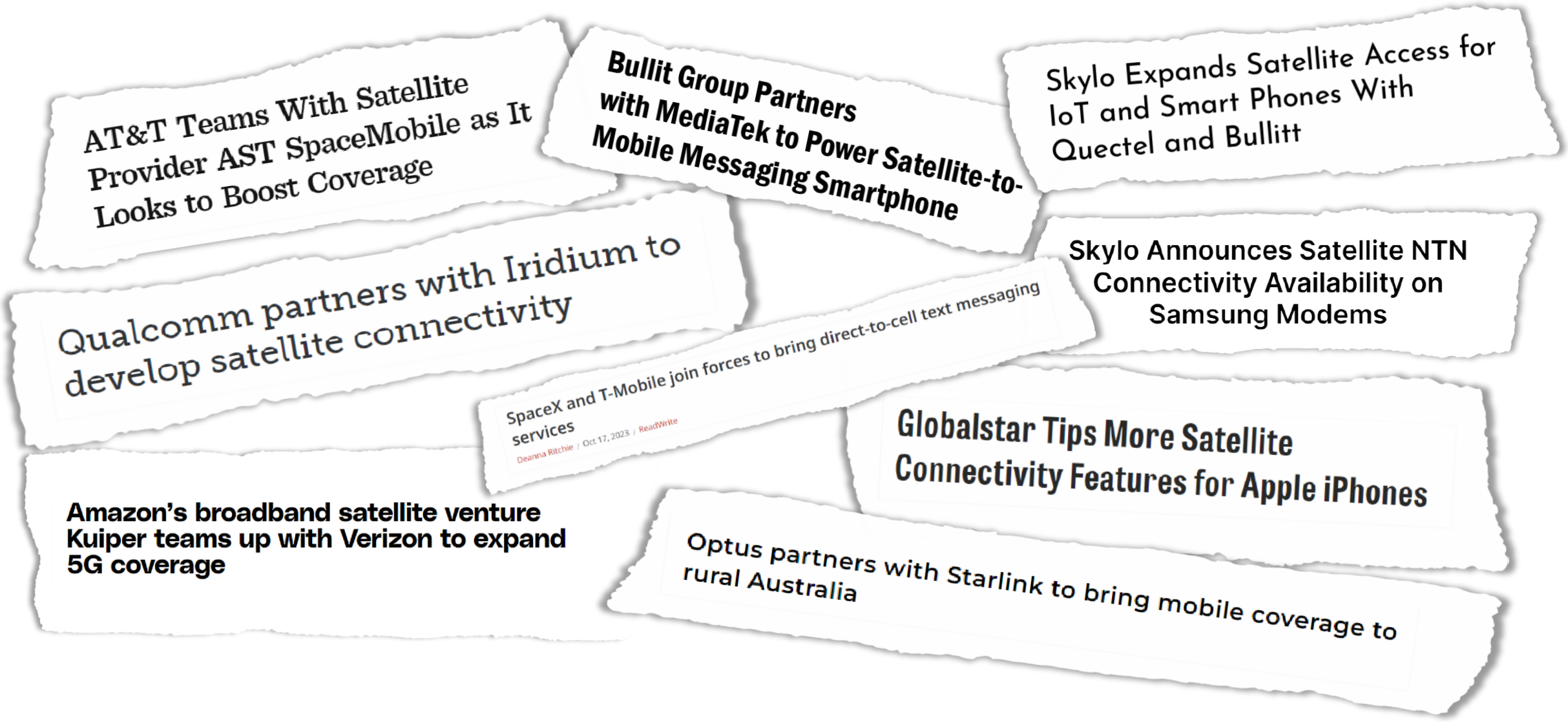
Operator	Satellite system (deployed)	Spectrum	Technology	Operational	Services
Space X	2016 LEO (0)	MNO spectrum/ 2GHz MSS	Pre Rel-17 3GPP	2024	Messaging, speech, broadband
AST SpaceMobile	243 LEO (1)	MNO spectrum	Pre Rel-17 3GPP	2024	Messaging, speech, broadband
Lynk	5000 LEO (3)	MNO spectrum	Pre Rel-17 3GPP	2Q2023	Messaging, LDR (low-data rate)
Sateliot	250 LEO (1)	2.0GHz MSS	Rel-17 NB-IoT (NB-NTN)	TBD	NB-IoT
Iridium	66 LEO	L-band	Proprietary	Yes	LDR/Messaging
Orbcomm	31 LEO	137-150 MHz	Proprietary	Yes	Assets tracking
GlobalStar	24 LEO	L/S-band	Proprietary	Yes	Assets tracking
Ligado	1 GEO	L-band	Rel-17 NB-IoT (NB-NTN)	TBD	NB-IoT

Trials, PoCs and RFPs for 5G NTN solutions have started already!

(Source: 5G Americas)

PARTNERSHIPS ARE CREATED ALONG THE 5G NTN JOURNEY

Satellite Operators, Mobile operators, Device Manufacturers, Chipset Vendors



ENVISIONED 5G NTN MARKET EVOLUTION

2022 2023 2024 2025 2026 2027 2028 2029

We Are Here

DVB S2X

Proprietary Optimization

Cellular Backhaul

Overlay on existing satellite solutions optimized for 4G/5G Cellular Backhaul

High Bandwidth

Gilat market leader!

Narrowband

Un-modified smartphones (pre-R17, MNO spectrum)

Smartphones & IoT Devices with R17 NTN capabilities

Using existing Transparent Satellites

Broadband

VSATs/ESIMs with R18 NTN capabilities

Using existing Transparent Satellites

Enhanced Broadband

VSATs/ESIMs with R19 NTN capabilities

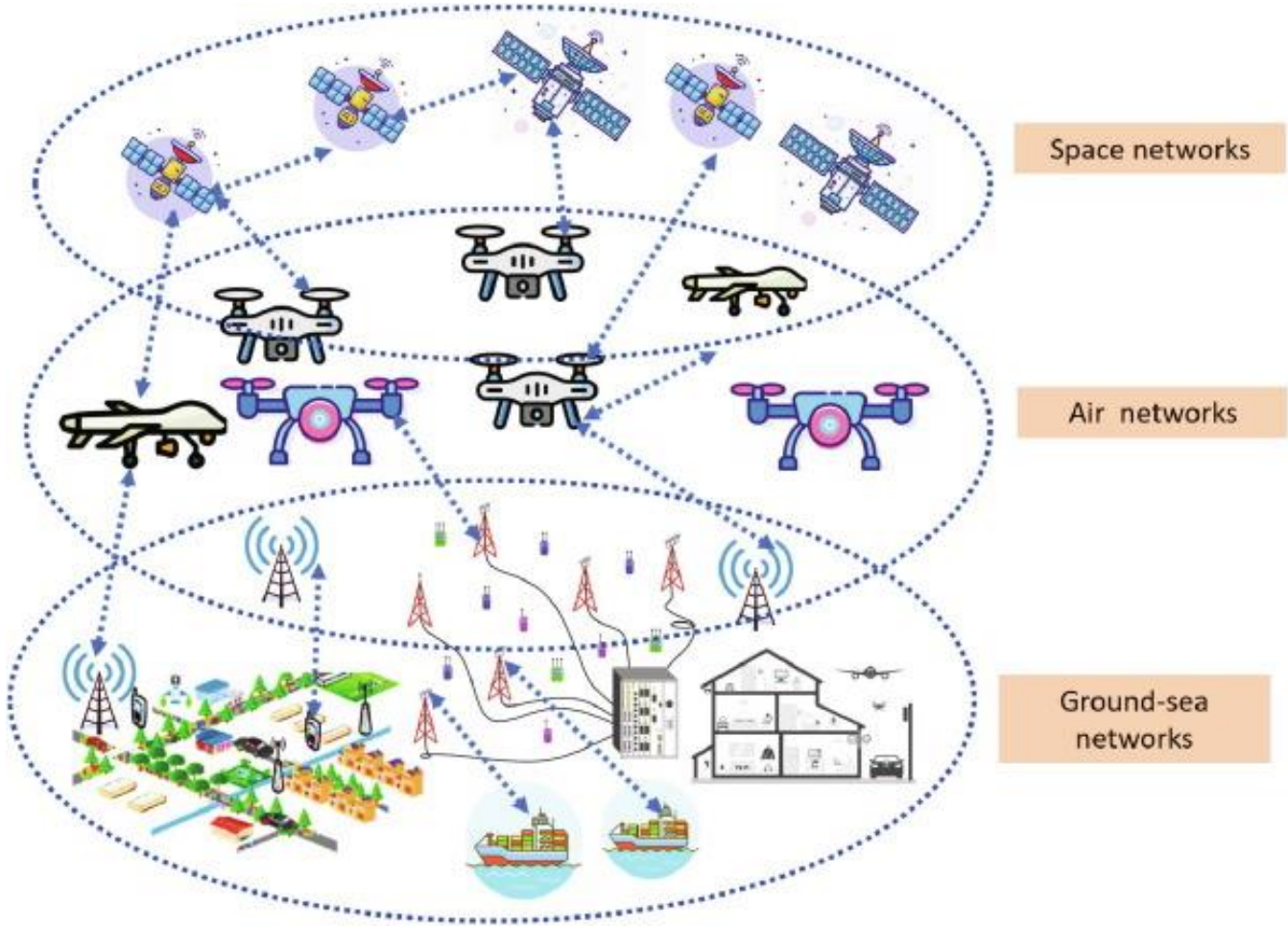
Using new Satellites with Regenerative OBP

5G

Higher Bandwidth, Lower Latency, Higher Capacity

6G NETWORK – Y2030+

- 3D Network – Space, Air, Ground-Sea
- Unified Design
- Multi-Layer Communication
- Ubiquitous Coverage
- AI-powered Radio, Edge, Core
- 6G Innovative Applications



THANK YOU

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